

# Clinical-Surgical Conferences

COOK COUNTY HOSPITAL

## Traumatic Injuries To the Major Abdominal Vessels

### MODERATOR:

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### DISCUSSANT:

THOMAS STARZL, M.D.

*Department of Surgery, Northwestern University Medical School*

DR. ROBERT J. FREEARK: For those of you visiting this Conference for the first time, it might be of interest to know that this is a weekly occurrence at County. Our practice has been to take some of the interesting material encountered here and invite speakers, both from outside the hospital as well as from our own staff, to discuss the various problems encountered in the surgical wards of this hospital. Finding a speaker to discuss traumatic injuries to the major abdominal vessels is not an easy task. Most prominent vascular surgeons are somewhat removed from the emergency traumatic vascular injury as encountered in a large charity hospital. In a hospital such as ours, the therapy of major vessel injury usually falls to the resident or house staff, simply because this type of injury is most frequently the result of gunshot or stab wounds, only occasionally nonpenetrating trauma and, as such, are seen first by the house officers. Therefore, as a rule, the younger generation of surgeons deals with these problems.

With us today is, by his appearance, one of these younger surgeons. In terms of experience, however, he has aged rapidly as the result of some of these traumatic vascular problems. Dr. Thomas Starzl is a member of the faculty at Northwestern University Medical School. His travels since our undergraduate days together have included places like Johns Hopkins University and Hospital, the University of Miami, and the Jackson Memorial Hospital. He is certified in both general and thoracic surgery, and throughout his training has been interested in vascular surgery. He had an unusual experience several years ago in encountering a number of these major vascular injuries while a resident and staff officer at the University of Miami. He has written an excellent article on traumatic injury of the vena cava, and he is well qualified to discuss the two cases we will present today.

### Case 1

DR. EDWARD BEHELER, surgical resident: A 22 year old Negro male was admitted to Cook County Hospital on March 20, 1960, at 8 a.m. four hours after sustaining a single gunshot wound in the right upper portion of the abdomen. His blood pressure was 80/40mm. Hg. pulse rate 108 per minute, respiration 30 per minute. The significant physical findings were limited to the abdomen, which was rigid, tender, and silent. No exit wound was noted. Urinary catheterization returned 370 cc. of clear urine,

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and stool benzidine was 3 plus. Admission hematocrit was 33 per cent.

One and a half hours after admission, with blood running via an arm "cutdown," the patient was taken to the operating room. Under general endotracheal anesthesia he underwent laparotomy through a right paramedian incision. The abdominal cavity was filled with blood which arose chiefly from a through-and-through wound of the right lobe of the liver. There was a large retroperitoneal hematoma which, on mobilization of the right colon and duodenum, had resulted from a tangential wound of the anteromedial wall of the inferior vena cava and, in addition, complete transection of the splenic vein at its union with the superior mesenteric vein. The latter wound caused partial loss of the medial wall of the portal vein. In addition, there was a through-and-through wound of the second portion of the duodenum just distal to the bulb, and a transection of a major lymphatic channel.

DR. FREEARK: You can appreciate the blood bath that Dr. Beheler found himself in. I have drawn on the blackboard the anatomical problem which was presented to the surgeon. All structures posterior to the retroduodenal and retropancreatic. The splenic vein was sheared off with some injury to the portal vein. The vena cava behind these structures was tangentially injured.

We will ask the patient to come in now (patient entered). His recovery has been remarkably uneventful. He has some residual drainage from the drain site but is really doing quite well (patient left). Dr. Starzl, the discussion is now all yours.

DR. THOMAS STARZL: I would compliment Dr. Beheler on this remarkable achievement of salvaging such a patient. It is a very unusual circumstance to have recovery from inferior vena cava injury. In 1956 there had been only seven reported instances of recovery after gunshot wound of the inferior vena cava, and six of these occurred in nonmilitary injuries. The only military wound recovery occurred in the British army. The American army had no reported survivals in these cases in World Wars I and II and the Korean War. This may have been due to serious injury both to the vena cava and other viscera, which precludes survival if there

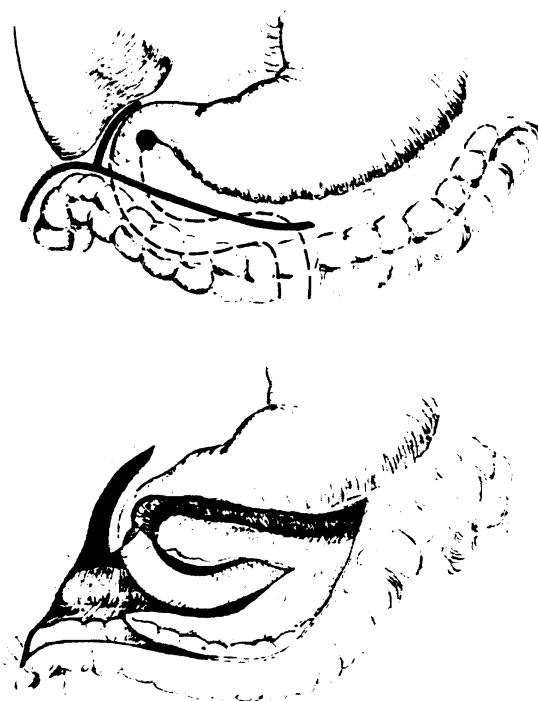


Figure 1. (After Russell Drake) Peritoneal incisions (above) and reflections (lower) for exploration of the inferior vena cava above the level of the renal veins. The location of the bullet tract in Case 1 is indicated by a solid circle (The American Surgeon 23:455, 1957).

is a prolonged period between the time of injury and operation. The time lag may account for the fact that most survivals have been in civilian injuries, which can be treated promptly.

In the fall of 1956 we had the opportunity within a period of 10 weeks to see and treat three cases of inferior vena cava injury. One of these was above the renal veins and is the second reported case of survival after injury in that location. Dr. Beheler's is the third case, since there have been no reports since ours in 1957. During the care of these patients and in reviewing the literature, certain principles of therapy became apparent. I would like now to try to develop them and draw some comparisons to the case presented.

The first case we saw in a 27 year old Negro male, shot in the abdomen at close range. The wound of entry was almost exactly between the umbilicus and the xiphoid process and passed trans-abdominally, the wound of exit being in the right costovertebral angle. The patient was in

shock. A "cutdown" was placed, and he was taken immediately to surgery where he was given 2,000 cc. of blood and was explored. We found a trajectory very similar to Dr. Beheler's, except that the wound of entry into the retroperitoneal space was located higher (Fig. 1). It injured the duodenum in two places and nipped off the margin of the pancreas and then disappeared.

The first thing that seems to be common to all these injuries was noted by Dr. Beheler too: it is that, although there was a good deal of blood in the peritoneal cavity, truly massive hemorrhage had ceased by the time the patient was explored. If this were not the case, I don't believe any of them could be treated. Instead of having continuing exsanguinating hemorrhage, the signal finding in this case was the presence of hematoma behind the pancreas. We suspected injury of the common duct and portal vein, and we did several things because of this. We enlarged the incision, obtained good light, made sure we had plenty of blood available, placed IV's in the arm, and added vascular instruments on the table. We then explored the area of the hematoma, incising the superior leaf of the transverse mesocolon and brushing the mesocolon down, thereby mobilizing the hepatic flexure (Fig. 1). By a Kocher maneuver, we got into the area of the hematoma and had massive bleeding, controlled by a desperate finger thrust into the bleeding hole in the vena cava. We eventually managed to get control above and below the site of injury.

This brings up the second thing to mention: In vena caval injury, if you have a number of intercostals emptying into the vessels between the controlling clamps above and below, the collateral drainage from the lumbar vessels may be so profuse as to allow hemorrhage almost as severe as if the major vessel were open. This is different from the arterial injury, and eventually you will have to apply local pressure or a curved clamp and isolate that segment.

Our first patient had injury to the common duct, duodenum, and pancreas and some small bowel perforations; but he survived. He actually had a fairly uncomplicated course.

The second case occurred a short time later. In this instance the wound of entry was at just about the same place. It entered the retroperitoneal space at the ligament of Treitz; so it was

below the renal vein (Fig. 2). There was injury of the contiguous aorta, and when the patient was explored, a hematoma was found in the retroperitoneal space. Massive bleeding had ceased, and there was plenty of time to make the necessary arrangements, including enlarging the incision, securing good lighting, having the blood checked, a "cutdown," and so on. In this instance the hematoma was pulsating slightly, and we suspected aortic injury. Just as we completed arrangements to explore the retroperitoneal space, the false aneurysm ruptured, but it was not hard to control. The aortic lesion and the vena caval lesion were repaired.

I think this type of injury is the basic cause for one of the most common late complications of inferior vena cava injury, that is, development of aortic-inferior vena cava fistula. This case provided a perfect set-up for such a fistula, some of which have been discovered 10 days to 10 years after the primary injury.

The third case I will mention to condemn our management. Again the injury was just at the ligament of Treitz (Fig. 2). In this instance the patient had been shot as he was fleeing from

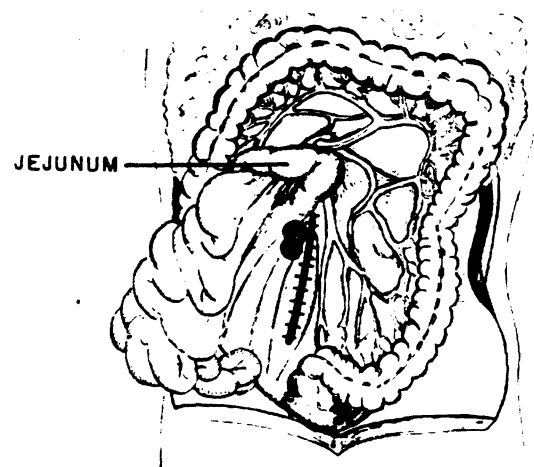


Figure 2. (After Kay Hyde) Peritoneal incision through the left leaf of the small bowel mesentery at its base for exposure of the inferior vena cava below the transverse mesocolon. The upper and lower solid circles indicate the levels of caval injury in Cases 2 and 3 respectively of the discussion (*The American Surgeon* 23:461, 1957).

the scene of a crime. The bullet, entering the back, had lost some of its velocity by the time it hit the vena cava. There were two linear tears in the vessel. The bullet also ripped off some of the lumbar veins, but the patient was not in shock and did not look particularly ill. We did not suspect major vessel injury; but on entering the abdomen, we found the telltale hematoma and cessation of bleeding. An assistant was intrigued by the hole in the retroperitoneal space. He put his finger into it, and when he took it out, there was massive hemorrhage of 1,000 cc. of blood. A finger was put back into the hole immediately and stayed there for two or three hours. In this injury the basic exposure of the vena cava was provided by an incision at the base of the mesentery of the small bowel, but the injury was so extensive that we could not get good exposure. Therefore, the entire small bowel was removed from its attachment to the retroperitoneal space and with most of the colon was brought up on the chest so that the retroperitoneal space was widely opened. In addition to the two vena caval tears anterior and posterior and the areas where the lumbar had been ripped off, this man also had multiple small bowel perforations. We tried to control bleeding by controlling the iliacs, but he tore the iliac vessel.

This again illustrates the problem of control of massive venous bleeding. It was impossible in this case to do that with clamps at any distance above and below the site of injury, making local pressure necessary. This patient recovered but developed iliofemoral thrombosis. He was finally discharged from the hospital a month later.

I would like now to answer a question which I am sure many of you must be asking yourselves: If you have a wound in the inferior vena cava with a small retroperitoneal hematoma and bleeding has ceased, why is it necessary to explore the space to repair the vessel? You do this because you have no assurance that bleeding will not recur. In Dr. Beheler's case as in our cases, there was injury to other retroperitoneal structures which could not have been satisfactorily repaired without getting into the area of the hematoma. Such untreated retroperitoneal injuries have a mortality of 100 per cent; that is the reason why repair is necessary in most of these cases.

What were the lessons we learned from our own cases? In those patients who actually get to the hospital with such injuries that can be treated, massive bleeding has ceased. On exploration of the abdomen the signal finding is a retroperitoneal hematoma usually, but not always, large. When it is found in the vicinity of the great vessels, a methodical program for exploring the retroperitoneal space should be instituted before manipulation is done, including getting blood, adjusting the lighting, preparation of necessary vascular instruments, and planning a wide exposure, which usually involves extending the original incision. For vena caval injury below the transverse mesocolon, exposure can be obtained by making an incision along the base of the small bowel mesentery. For injury above the transverse mesocolon, the best exposure is a combination of the Kocher maneuver with mobilization of the colon and sweeping down the transverse mesocolon. The ultimate in exposure in lesions below the transverse mesocolon can be obtained by detaching the entire small bowel from the retroperitoneal connections and putting it on the chest wall.

Despite the fact that these are venous injuries, we did not use anticoagulants in our cases, and we do not think they are indicated unless the lesions are unusually severe and multiple.

The final lesson from our cases is worth remembering: Two of the patients were shot by irate husbands who caught them in their wives' bedrooms!

**DR. FREEARK:** A word to the wise is sufficient. Now I would like to reemphasize several of Dr. Starzl's points. Having vascular clamps ready at surgery is very important. Dr. Beheler has said that they were available to him on the initial exploration without having to wait to have them sterilized. This he thinks was a significant factor in the patient's recovery. Vascular clamps adequate to deal with these problems should be part of every emergency laparotomy set-up.

The performance of venous "cutdowns" in the arm is equally important. Many patients are taken to the operating room with the "cutdown" in a leg. We had the experience of pumping about 10 pints of blood into the leg of a patient with injury in the iliac vein, and the majority of the blood was coming right out the wound up above. It was only late in the course of events that this

was recognized. An arm "cutdown," therefore, is a very important factor.

What about ligating the portal vein? Would you feel that that is inevitably fatal?

DR. STARZL: In the dog, ligation of the portal vein is fatal, but man usually tolerates it. Dr. Childs conducted an experiment with dogs and monkeys and found there was little fatality in monkeys. This is presumably due to the fact that in the monkey retroperitoneal venous collaterals are better developed because the area around the pancreas and duodenum is plastered to the retroperitoneal space, whereas it is not in the dog. He has done portal vein ligation in man as the first stage of a Whipple operation, and he has not had a fatality. By the time the patient is ready for the second stage, the portal pressure has generally returned to normal.

DR. FREEARK: Were those veins partially occluded?

DR. STARZL: That is always a possibility in case of tumor, but in monkeys it was not a consideration. I think it would have to be accepted that there is an additional factor of tributary clotting in the type of portal occlusion that gives portal hypertension. It is not simply main vessel obstruction.

That brings up the problem of trying to ligate the vena cava at the level that Dr. Beheler's patient's injury occurred. It is generally accepted that that would almost always be fatal. Dr. Beheler could not have done anything else here, since most investigators feel that death ensues if acute ligation is done above the renal vessels.

DR. FREEARK: The genitourinary service has ligated above the renal vessels in patients whose tumors have occluded the vein. I am sure that there must be a long series of unreported vena caval injuries that have occurred during the performance of lumbar sympathectomy, and anyone who has been in on such a problem has learned about getting proximal and distal control. It is very effective to take two stick sponges and apply point pressure at a right angle to stop blood loss from a tangential injury of the lateral vena caval wall.

It is curious how these cases will come to us in threes. Between the two cases presented today, Dr. Norcross had a patient with a through-and-through gunshot wound of the vena cava above the renals, and he had some difficulty in dealing

with the posterior wound. That patient did not survive. Did you learn any special lessons from that case?

DR. WILLIAM NORCROSS, department of surgery: Our case demonstrated the difficulty in adequately exposing the vena cava high in its abdominal course and the malevolent effect of massive transfusion on the normal clotting mechanism. It further demonstrated the difficulty in obtaining proximal control of the vena cava in this area. The entrance wound was apparent in the right 5th intercostal space in the nipple line. On exploration of the abdomen, there was evidence of previous intraperitoneal hemorrhage. No active bleeding was encountered at this time. On further exploration, it was seen that the bullet had entered the abdominal cavity and traversed the liver to enter the vena cava anteriorly just inferior to the hepatocaval juncture. The hematoma anterior to the vena cava was deceptively small, no larger than 5 cc. There was moderate to marked pericaval fibrosis, apparently subsequent to previous intraabdominal inflammatory disease. It was apparent that proximal control could be obtained only by extending the right paramedian incision into the chest, incising the diaphragm and mobilizing the right lobe of the liver. Unfortunately, while this was being accomplished, there was onset of massive hemorrhage from the caval wounds. The bullet, entering anteriorly, had traversed the cava obliquely and exited posteriorly at the level of the adrenal veins. Though bleeding could be controlled with digital pressure, it was soon apparent, even with mobilization of the liver, that the space of required dissection was so small that it was difficult to dissect and at the same time be able satisfactorily to control oozing from the posterior vena caval wound. This circumstance resulted in an unfortunately large loss of blood, requiring massive replacement. Once adequate exposure was obtained, the wounds were repaired with little further difficulty. On closure and throughout the postoperative period, we were confronted with a rather constant ooze from all wounded surfaces. A hematologic consultation was obtained, and a diagnosis of thrombasthenia was made. This was treated with ACTH, frozen plasma, and so on, but the patient continued to bleed and expired on the third postoperative day from the consequences of this acute blood dyscrasia.

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QUESTION: In the case presented by Dr. Behe-  
ler how was the portal or splenic vein handled?

DR. FREEARK: The splenic was ligated and  
the portal was repaired. Ligation of the splenic  
vein is usually well tolerated. It was not felt  
that it was necessary to remove the spleen.

What about the splenic artery? If you had to  
sacrifice it would you think the spleen should  
come out?

DR. STARZL: No. We have done elective sur-  
gery with the use of the splenic artery. We did  
a splenorenal arterial anastomosis. In lesions of  
the upper abdominal aorta, such as renal artery  
stenosis, we have cut the splenic artery and mo-  
bilized it and revascularized one of the kidneys,  
but we did not think of removing the spleen.

QUESTION: I would like to know the approach  
to repair in this case.

DR. FREEARK: They took down the hepatic  
flexure of the colon and mobilized the duodenum,  
much as outlined by Dr. Starzl. I believe it  
would prove satisfactory for most injuries above  
the transverse colon.

QUESTION: What would you do in a through-  
and-through wound of the vena cava?

DR. STARZL: I would repair both anterior and  
posterior rents. A technic which is intriguing  
but one we did not use would be to close the  
posterior hole from within the vessel. This would  
involve leaving one silk knot within the lumen,  
but it would avoid the difficulty of exposing the  
posterior wall of the cava from its external sur-  
face.

#### Case 2

DR. DALE SNYDER, surgical resident: A 38  
year old Negro male entered Cook County Hos-  
pital on Oct. 28, 1959, an undetermined time  
after sustaining a gunshot wound of the chest.

On admission he appeared terminal and was  
described as stuporous, cold, and clammy. His  
blood pressure was 70/40 mm. Hg, pulse rate  
72 per minute, respiratory rate 20 per minute.  
An entrance wound was over the left seventh rib  
just medial to the anterior axillary line. No  
exit wound was noted and the chest was clear to  
physical examination. The abdomen was soft,  
not tender, but bowel sounds were absent.

A unit of plasma was started, followed by sa-  
line while blood was being prepared. Emergency

roentgenograms revealed a clear chest and a me-  
tallic object in the projection of the retroperi-  
toneal area below the diaphragm. Urinalysis was  
negative and emergency hematocrit was 36 per  
cent. Exploration two hours after admission re-  
vealed wounds of the transverse colon, proximal  
jejunum, and right renal artery at the junction  
of the aorta. The left renal vein in the portion  
crossing anterior to the aorta was partially sev-  
ered.

DR. FREEARK: This patient's problem is also  
shown on the blackboard. He too presented the  
problem of a surgical approach to a great deal  
of active bleeding that was not retroperitoneal  
but intraabdominal. His left renal vein was par-  
tially severed, as was the right renal artery at  
its origin from the aorta. Bleeding could be con-  
trolled by a well-placed sponge and pressure. The  
problem was how to get proximal control. In  
order to get at the wound in the aorta, it was  
necessary to complete the transection of the renal  
vein. This finished, the patient had a pulse in  
the renal artery, but there was some narrowing  
that presented the question of ischemia to the  
right kidney. The situation was equally disturb-  
ing on the left because the left vein was sacri-  
ficed, and I assume that ligation of a renal vein  
is just as fatal as ligation of the vena cava above  
the renal vein. Here we had the problem of renal  
venous death on the one side and renal artery  
death on the other side. What should we have  
done here?

DR. STARZL: I expect the patient was dying  
at the time he was explored so your hands were  
forced, and you did what you could do quickly  
to avoid having him die on the table. You knew  
at the time that ligation of the renal vein is al-  
most inevitably followed by death of that kidney.  
Except for certain anatomical anomalies, death  
will follow in all cases. The type of anomaly that  
might lead to salvage of the kidney is periaortic  
venous plexus in which part of the venous return  
of the kidney goes behind the aorta and part in  
front so you have a periaortic ring. In such a  
case you could ligate the anterior branch with-  
out harmful effect since the posterior branch  
would take care of it. But that only occurs in  
2 to 10 per cent of cases. In this particular case  
I would have been tempted to cut off the right  
renal artery and reanastomose it to the aorta,  
because in a young patient with supple vessels

this procedure would not be too difficult. These aortic injuries are better understood and treatment is more standardized than the venous injuries. Essentially it consists of control above and below the site of exit; the repair of vessels is not difficult because the collateral inflow is not great.

Dr. Freeark has opened the door for a discussion of the complicated vascular lesions at the level of the renal artery in which obtaining control involves temporarily devascularizing certain viscera, such as the kidney, which in itself may have a terrific mortality. I am sure, in this case, that to do any more than they did would have meant greater insult to the kidney. It takes at least 15 minutes to accomplish a reanastomosis of one of these visceral arteries, and as a result, the patient may have ischemia of the organ that surely leads to death.

DR. FREEARK: Dr. Starzl is the author of a brilliant movie. He and his group undertook a thromboendarterectomy of the aorta in which the thrombus involved not only the renal artery but the superior mesenteric. He handled the vascular supply to these organs by a series of partial occlusion clamps.

DR. STARZL: That patient had had for years a thrombus that extended from the terminal aorta distally. Six months before he came to us he had malignant hypertension; he had symptoms of intestinal angina with abdominal pain after eating; and he had a blood pressure that was often 300. The thrombus had completely occluded the left renal artery. The right renal artery was reduced to a stenotic area, and there was partial occlusion of the superior mesenteric artery. This man was cooled and we explored him. The incision used could be applied to high aortic injuries. A vertical abdominal incision is extended into the ninth intercostal space. You lift the pancreas and spleen to the right, and do the usual left colectomy mobilization. We made that incision, put clamps on above the superior mesenteric artery, and removed the thrombus. The period of occlusion on this was about one hour. The patient's temperature was 30 C., and we had postoperative evidence of pretty severe bowel injury with hemorrhage. He survived, but he was awfully sick.

DR. FREEARK: We felt that our patient had two sources of venous outflow from the left kidney. He had a large adrenal vein above it and

a good sized spermatic vein distal to the point of ligation. We hoped that the adrenal venous outflow could come down through the spermatic and pick up return to the heart that way. On the arterial side there did not seem to be anything more in order. This patient was anuric postoperatively. His blood pressure was restored for a while, but he expired two days after surgery.

DR. SNYDER: Postmortem examination revealed a right kidney that appeared normal light brown in color. The pathologist said it was only very slightly congested with some contraction of the right renal artery. The left kidney was large and pale; it looked like a "shock kidney." The large dilated spermatic and adrenal veins on that side showed there was some utilization of that collateral channel, but it was not adequate. There was a typical "shock kidney" picture on the left.

DR. FREEARK: Have you had experience with venous grafts in humans in replacing segments of vein?

DR. STARZL: I have not personally, and those who have worked with them have reported poor results. Veins have no pressure to keep them open. They look good at first but slowly shrink down and occlude. Dr. DeBakey has said categorically that venous grafts will fail particularly below the diaphragm; he thinks they should not be used.

DR. FREEARK: How do you feel about draining such a repair?

DR. STARZL: We drained all our cases extensively. I think the tip of the drain should be close to the suture line, and we use Penrose drains.

DR. FREEARK: We all thank you, Dr. Starzl, for an interesting and helpful discussion.

#### Points to be remembered

1. Major vascular injury represents one of the few true surgical emergencies of abdominal trauma.
2. While gunshot and stab wounds account for most such emergencies, it is important to remember that they may occur in non penetrating trauma. Vessels, such as the inferior vena cava, may be lacerated by blunt trauma.
3. In most instances the need for surgical intervention is obvious, and the major preoperative efforts should be directed toward restoration of blood loss and the assessment of damage to

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viscera not readily examined at the time of laparotomy.

1. The following sins of omission are to be avoided in the preoperative evaluation of such a patient:

- (a) Failure to identify the path of a missile in which there is no exit wound. General condition permitting, failure to establish course of the missile by anterior-posterior and lateral x-rays based upon the missile's resting site. Some apparently penetrating wounds may be quickly reclassified as nonpenetrating.

5. The degree of preoperative restoration of blood volume is one of the most difficult decisions to make, and there is no good laboratory aid to assist. Most patients with major vascular wounds who arrive at the hospital alive will be benefited by preoperative transfusions and some delay in operative intervention.

6. Where a major vessel wound to the vena cava or iliac vessels is anticipated, it is wise to

place the "cutdown" in an arm vein rather than a leg, so that transfused blood is not immediately lost through the wound in the vessel.

7. The operative management of major vessel injury requires a knowledge of what vessel may safely be ligated, and which ones must be repaired or the viscera they supply be resected.

In general the following vessels must be repaired:

- (a) Aorta and iliac arteries
- (b) Hepatic artery propria (distal to right gastric and gastroduodenal artery)
- (c) Superior mesenteric artery and vein
- (d) Inferior vena cava above the renal veins
- (e) Portal vein

The following vessels should either be repaired or the viscera which they supply removed:

- (a) Cystic artery (gallbladder)
- (b) Appendiceal artery (appendix)
- (c) Renal artery and vein (kidney)

## Second CAMP MEMORIAL LECTURE

**John B. Reckless, M.B., Ch.B.**

**Duke University Medical Center, Durham, N.C.**

**"The Facts of Life in the Future of Medicine"**

**May 17, 1:30 P.M.**

**Grand Ballroom**

**Sherman Hotel**